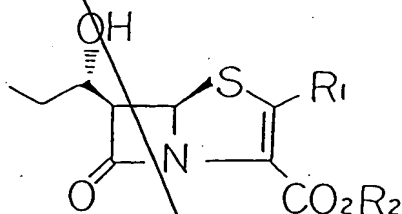


CLAIMS

1 1. A penem derivative represented by the follow-  
2 ing formula (I):



3  
4 wherein  $R_1$  represents a substituted or unsubstituted  
5 alkyl group, a substituted or unsubstituted alkenyl  
6 group, a substituted or unsubstituted aralkyl group, a  
7 substituted or unsubstituted aryl group, a substituted  
8 or unsubstituted alkylthio group, a substituted or un-  
9 substituted alkenylthio group, a substituted or un-  
10 substituted aralkylthio group, a substituted or un-  
11 substituted arylthio group, a substituted or un-  
12 substituted heterocyclic group, a substituted or un-  
13 substituted heterocyclic thio group, a substituted or  
14 unsubstituted acylthio group, a mercapto group or a  
15 hydrogen atom, and  $R_2$  represents a hydrogen atom or a  
16 carboxyl-protecting group; or a pharmacologically ac-  
17 ~~ceptable salt thereof.~~

1 2. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 1, wherein in  
3 the formula (I),  $R_1$  represents a substituted or un-

4 substituted heterocyclic thio group.

1 3. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 2, wherein the  
3 heterocyclic group of said substituted or unsubstituted  
4 heterocyclic thio group is any one of the following  
5 substituted or unsubstituted groups (a) to (h):

6 (a) a 3-8 membered, unsaturated or saturated,  
7 heteromonocyclic group containing 1 to 4  
8 nitrogen atoms;

9 (b) a 7-12 membered, unsaturated,  
10 heteropolycyclic group containing 1 to 5  
11 nitrogen atoms;

12 (c) a 3-8 membered, unsaturated or saturated,  
13 heteromonocyclic group containing 1 to 2  
14 oxygen atoms and 1 to 3 nitrogen atoms;

15 (d) a 7-12 membered, unsaturated,  
16 heteropolycyclic group containing 1 to 2  
17 oxygen atoms and 1 to 3 nitrogen atoms;

18 (e) a 3-8 membered, unsaturated or saturated,  
19 heteromonocyclic group containing 1 to 2 sul-  
20 fur atoms and 1 to 3 nitrogen atoms;

21 (f) a 7-12 membered, unsaturated,  
22 heteropolycyclic group containing 1 to 2 sul-  
23 fur atoms and 1 to 3 nitrogen atoms;

24 (g) a 3-8 membered, unsaturated or saturated,

25 heteromonocyclic group containing 1 to 2  
26 oxygen atoms; and  
27 (h) a 3-8 membered, unsaturated or saturated,  
28 heteromonocyclic group containing one sulfur  
29 atom.

1 4. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 3-8 membered, unsaturated or saturated,  
4 heteromonocyclic group containing 1 to 4 nitrogen atoms  
5 and represented by (a) is a pyrrolyl, pyrrolidinyl, im-  
6 idazolyl, pyrazolyl, pyridyl, pyrimidyl, pyrazinyl,  
7 pyridazinyl, triazolyl, tetrazolyl, dihydrotriazinyl,  
8 azetidiny, pyrrolidinyl, imidazolidinyl, piperidinyl,  
9 pyrazolidinyl or piperazinyl group.

1 5. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 3-8 membered, unsaturated or saturated,  
4 heteromonocyclic group containing 1 to 4 nitrogen atoms  
5 and represented by (a) is a pyrrolidinyl group.

1 6. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 3-8 membered, unsaturated or saturated,  
4 heteromonocyclic group containing 1 to 4 nitrogen atoms  
5 and represented by (a) is an (S)-pyrrolidin-3-yl group.

1 7. A penem derivative or a pharmacologically ac-

2       ceptable salt thereof according to claim 3, wherein  
3       said 3-8 membered, unsaturated or saturated,  
4       heteromonocyclic group containing 1 to 4 nitrogen atoms  
5       and represented by (a) is a piperidinyl group.

1           8. A penem derivative or a pharmacologically ac-  
2       ceptable salt thereof according to claim 3, wherein  
3       said 3-8 membered, unsaturated or saturated,  
4       heteromonocyclic group containing 1 to 4 nitrogen atoms  
5       and represented by (a) is a piperidin-4-yl group.

1           9. A penem derivative or a pharmacologically ac-  
2       ceptable salt thereof according to claim 3, wherein  
3       said 3-8 membered, unsaturated or saturated,  
4       heteromonocyclic group containing 1 to 4 nitrogen atoms  
5       and represented by (a) is a piperidin-3-yl group.

1           10. A penem derivative or a pharmacologically ac-  
2       ceptable salt thereof according to claim 3, wherein  
3       said 7-12 membered, unsaturated, heteropolycyclic group  
4       containing 1 to 5 nitrogen atoms and represented by (b)  
5       is an indolyl, isoindolyl, indoliziny, benzimidazolyl,  
6       quinolyl, isoquinolyl, indazolyl, benzotriazolyl,  
7       tetrazolopyridyl, tetrazolopiridazinyl or  
8       dihydrotriazolopyridazinyl group.

1           11. A penem derivative or a pharmacologically ac-  
2       ceptable salt thereof according to claim 3, wherein  
3       said 3-8 membered, unsaturated or saturated,

4 heteromonocyclic group containing 1 to 2 oxygen atoms  
5 and 1 to 3 nitrogen atoms and represented by (c) is an  
6 oxazolyl, isooxazolyl, oxadiazolyl or morpholinyl  
7 group.

1 12. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 7-12 membered, unsaturated, heteropolycyclic group  
4 containing 1 to 2 oxygen atoms and 1 to 3 nitrogen  
5 atoms and represented by (d) is a benzoxazolyl or ben-  
6 zoxadiazolyl group.

1 13. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 3-8 membered, unsaturated or saturated,  
4 heteromonocyclic group containing 1 to 2 sulfur atoms  
5 and 1 to 3 nitrogen atoms and represented by (e) is a  
6 1,3-thiazolyl, 1,2-thiazolyl, <sup>h</sup>thiazolinyl, thiadiazolyl  
7 or thiazolidinyl group.

1 14. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein  
3 said 7-12 membered, unsaturated, heteropolycyclic group  
4 containing 1 to 2 sulfur atoms and 1 to 3 nitrogen  
5 atoms and represented by (f) is a benzothiazolyl or  
6 benzothiadiazolyl group.

1 15. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 3, wherein

3     said 3-8 membered, unsaturated or saturated,  
4     heteromonocyclic group containing 1 to 2 oxygen atoms  
5     and represented by (g) is a furanyl, pyranyl,  
6     tetrahydrofuranyl or tetrahydropyranyl group.

1           16. A penem derivative or a pharmacologically ac-  
2     ceptable salt thereof according to claim 3, wherein  
3     said 3-8 membered, unsaturated or saturated,  
4     heteromonocyclic group containing one sulfur atom and  
5     represented by (h) is a thienyl or tetrahydrothienyl  
6     group.

1           17. A penem derivative or a pharmacologically ac-  
2     ceptable salt thereof according to claim 1, wherein in  
3     the formula (I),  $R_1$  represents a substituted or un-  
4     substituted alkylthio group.

1           18. A penem derivative or a pharmacologically ac-  
2     ceptable salt thereof according to claim 17, wherein  
3     the alkyl group of said substituted or unsubstituted  
4     alkylthio group is a linear or branched lower alkyl  
5     group, or a monocyclic or polycyclic alkyl group which  
6     may be in the form of a fused ring with an aromatic  
7     hydrocarbon.

1           19. A penem derivative or a pharmacologically ac-  
2     ceptable salt thereof according to claim 17, wherein  
3     the alkyl group of said substituted or unsubstituted  
4     alkylthio group is a methyl, ethyl, n-propyl,

5 isopropyl, n-butyl, tert-butyl or hexyl group.

1 20. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 17, wherein  
3 the alkyl group of said substituted or unsubstituted  
4 alkylthio group is a monocyclic or polycyclic alkyl  
5 group selected from a cyclopentyl, cyclohexyl, menthyl,  
6 fenchyl, bornyl or indanyl group.

1 21. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 1, wherein in  
3 the formula (I),  $R_1$  represents a substituted or un-  
4 substituted alkenylthio group.

1 22. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 21, wherein  
3 the alkenyl group of said substituted or unsubstituted  
4 alkenylthio group is a linear or branched, lower  
5 alkenyl group.

1 23. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 21, wherein  
3 the alkenyl group of said substituted or unsubstituted  
4 alkenylthio group is a vinyl, allyl, 2-chloroallyl, 1-  
5 propenyl, 2-butenyl or 2-methyl-2-propenyl group.

1 24. A penem derivative or a pharmacologically ac-  
2 ceptable salt thereof according to claim 1, wherein in  
3 the formula (I),  $R_1$  represents a substituted or un-  
4 substituted aralkylthio group.

1           25. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 24, wherein  
3           the aralkyl group of said substituted or unsubstituted  
4           aralkylthio group is an aralkyl group containing 7 to  
5           24 carbon atoms.

1           26. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 24, wherein  
3           the aralkyl group of said substituted or unsubstituted  
4           aralkylthio group is a benzyl, phenethyl, 3-phenyl-  
5           propyl, 2-naphthylmethyl, 2-(1-naphthyl)ethyl, trityl  
6           or benzhydryl group.

1           27. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 1, wherein in  
3           the formula (I),  $R_1$  represents a substituted or un-  
4           substituted arylthio group.

1           28. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 27, wherein  
3           the aryl group of said substituted or unsubstituted  
4           arylthio group is an aryl group containing 6 to 10 car-  
5           bon atoms.

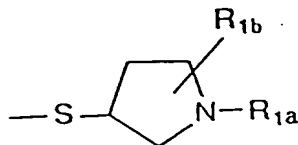
1           29. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 27, wherein  
3           the aryl group of said substituted or unsubstituted  
4           arylthio group is a phenyl, tolyl, xylyl, mesityl,  
5           cumenyl or naphthyl group.

1           30. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 1, wherein in  
3           the formula (I),  $R_1$  represents a substituted or un-  
4           substituted aryl group.

1           31. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 1, wherein in  
3           the formula (I),  $R_1$  represents a substituted or un-  
4           substituted heterocyclic group.

1           32. A penem derivative or a pharmacologically ac-  
2           ceptable salt thereof according to claim 1, wherein  $R_1$   
3           represents the following group (i) or (ii):

4           (i) a group represented by the following formula:



6           wherein  $R_{1a}$  and  $R_{1b}$  may be the same or different and  
7           represent a hydrogen atom, an alkyl group, an alkenyl  
8           group, an aralkyl group containing 7 to 24 carbon  
9           atoms, an aryl group containing 6 to 10 carbon atoms,  
10          an imino lower alkyl group, an imino lower alkyl amino  
11          group, an imino(amino) lower alkyl group, a carbamoyl  
12          group, a carbamoyl lower alkyl group, an acyl group,  
13          an acyl lower alkyl group, carboxyl group, a hetero-  
14          cyclic group or a heterocyclic lower alkyl group; one  
15          or more hydrogen atoms of said alkyl, alkenyl, aralkyl,

16 aryl, imino lower alkyl, imino lower alkyl amino,  
17 imino(amino) lower alkyl, carbamoyl, carbamoyl lower  
18 alkyl, heterocyclic or heterocyclic lower alkyl group  
19 may each be substituted by a halogen atom, a carboxyl  
20 group, a thiocarboxyl group, a formyl group, a nitro  
21 group, a cyano group, a hydroxyl group, an amino group,  
22 an imino group, a lower alkylene acetal group, an  
23 alkyl group, an alkoxyl group, an alkenyl group, an  
24 aralkyl group containing 7 to 24 carbon atoms, an aryl  
25 group containing 6 to 10 carbon atoms, an aryloxy group  
26 containing 6 to 10 carbon atoms, an imino lower alkyl  
27 group, an imino lower alkyl amino group, an imino-  
28 (amino) lower alkyl group, a carbamoyl group, a car-  
29 bamoyloxy group, a carbamoyl lower alkyl group, a  
30 heterocyclic group, a heterocyclic lower alkyl group,  
31 an acyl group or an acylalkyl group; said acyl groups  
32 and the acyl group of said acyl lower alkyl group  
33 represent an alkyl carbonyl, alkenylcarbonyl, aralkyl-  
34 carbonyl, arylcarbonyl, heterocyclic carbonyl or  
35 heterocyclic lower alkyl carbonyl group containing  
36 said substituted or unsubstituted alkyl, alkenyl,  
37 aralkyl, aryl, heterocyclic or heterocyclic lower alkyl  
38 group; said carboxyl group may be esterified by said  
39 substituted or unsubstituted alkyl, alkenyl, aralkyl,  
40 aryl, heterocyclic or heterocyclic lower alkyl group;

41 said heterocyclic groups and the heterocyclic group of  
42 said heterocyclic lower alkyl group may each contain  
43 one or more carbonyl group in the rings thereof and the  
44 tertiary nitrogen atom thereof may form an in-  
45 tramolecular quaternary salt by the introduction of  
46 said substituent; and

47 (ii) a group represented by the following formula:

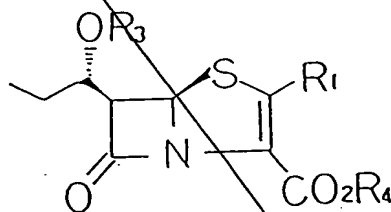


49 wherein n stands for 1 to 3;  $R_{1C}$  represents a hydrogen  
50 atom, an aryl group containing 6 to 10 carbon atoms, an  
51 amino group, an imino lower alkyl amino group, an  
52 aminosulfonyl group, carbamoyl group, acyl group, a  
53 carboxyl group or a heterocyclic group; one or more  
54 hydrogen atoms of said aryl, amino, imino lower alkyl, -  
55 amino, aminosulfonyl, carbamoyl or heterocyclic group  
56 may each be substituted by a halogen atom, a carboxyl  
57 group, a thiocarboxyl group, a formyl group, a nitro  
58 group, a cyano group, a hydroxyl group, an amino group,  
59 an imino group, an alkyl group, an alkoxy group, an  
60 alkenyl group, an aralkyl group containing 7 to 24 car-  
61 bon atoms, an aryl group containing 6 to 10 carbon  
62 atoms, an aryloxy group containing 6 to 10 carbon  
63 atoms, an imino lower alkyl group, an imino lower  
64 alkyl amino group, an imino(amino) lower alkyl group,  
65 a carbamoyl group, a carbamoyloxy group, a carbamoyl-

66 lower alkyl group, a heterocyclic group, a hetero-  
67 cyclic lower alkyl group, an acyl group or a acylalkyl  
68 group; said acyl groups and the acyl group of said  
69 acylalkyl groups recited as a substituent represent an  
70 alkylcarbonyl, alkenylcarbonyl, aralkylcarbonyl, aryl-  
71 carbonyl, heterocyclic carbonyl or heterocyclic lower  
72 alkyl carbonyl group containing one or more alkyl,  
73 alkenyl, aralkyl, aryl, heterocyclic or heterocyclic  
74 lower alkyl groups; one or more hydrogen atoms of these  
75 acyl groups may each be substituted by a halogen atom,  
76 a carboxyl group, a thiocarboxyl group, a formyl group,  
77 a nitro group, a cyano group, a hydroxyl group, an  
78 amino group, an imino group, a lower alkylene acetal  
79 group, an alkyl group, an alkoxy group, an alkenyl  
80 group, an aralkyl group containing 7 to 24 carbon  
81 atoms, an aryl group containing 6 to 10 carbon atoms,  
82 an aryloxy group containing 6 to 10 carbon atoms, an  
83 imino lower alkyl group, an imino lower alkyl amino  
84 group, an imino(amino) lower alkyl group, carbamoyl  
85 group, a carbamoyloxy group, a carbamoyl lower alkyl  
86 group, a heterocyclic group, a heterocyclic lower alkyl  
87 group, an acyl group or an acylalkyl group; said car-  
88 boxyl group may be esterified by a substituted or un-  
89 substituted alkyl, alkenyl, aralkyl, aryl, heterocyclic  
90 or heterocyclic lower alkyl group; said heterocyclic

91 group and the heterocyclic group of said heterocyclic  
 92 lower alkyl groups, the latter heterocyclic group being  
 93 recited as a substituent, may each contain one or more  
 84 carbonyl groups in the ring thereof and the tertiary  
 95 nitrogen atom thereof may form an intramolecular  
 96 quaternary salt by the introduction of said sub-  
 97 stituent.

1 33. A compound represented by the following for-  
 2 mula (II):

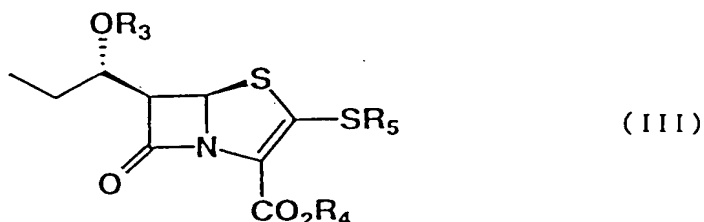


4 wherein R<sub>1</sub> represents a substituted or unsubstituted  
 5 alkyl group, a substituted or unsubstituted alkenyl  
 6 group, a substituted or unsubstituted aralkyl group, a  
 7 substituted or unsubstituted aryl group, a substituted  
 8 or unsubstituted <sup>alkenylthio</sup>alkylthio group, a substituted or un-  
 9 substituted alkenylthio group, a substituted or un-  
 10 substituted aralkylthio group, a substituted or un-  
 11 substituted arylthio group, a substituted or un-  
 12 substituted heterocyclic group, a substituted or un-  
 13 substituted heterocyclic thio group, a substituted or  
 14 unsubstituted acylthio group, a mercapto group or a

CO<sub>2</sub>  
cont

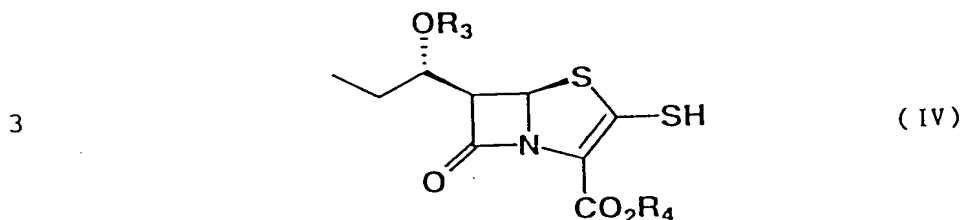
15 hydrogen atom, OR<sub>3</sub> represents a protected hydroxyl  
16 group, and R<sub>4</sub> represents a carboxyl-protecting group.

1 34. A compound represented by the following for-  
2 mula (III):



4 wherein R<sub>5</sub> represents a substituted or unsubstituted  
5 alkyl group, a substituted or unsubstituted alkenyl  
6 group, a substituted or unsubstituted aralkyl group, a  
7 substituted or unsubstituted aryl group, a substituted  
8 or unsubstituted heterocyclic group or a substituted or  
9 unsubstituted acyl group, OR<sub>3</sub> represents a protected  
10 hydroxyl group, and R<sub>4</sub> represents a carboxyl-protecting  
11 group.

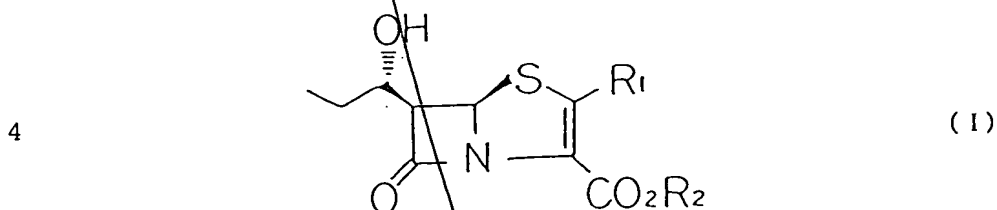
1 35. A compound represented by the following for-  
2 mula (IV):



4 wherein OR<sub>3</sub> represents a protected hydroxyl group and

5  $R_4$  represents a carboxyl-protecting group.

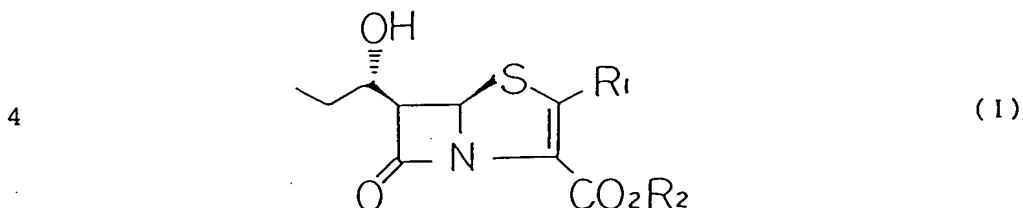
1 36. A medicament comprising, as an active in-  
2 gredient, a penem derivative represented by the follow-  
3 ing formula (I):



5 wherein  $R_1$  represents a substituted or unsubstituted  
6 alkyl group, a substituted or unsubstituted alkenyl  
7 group, a substituted or unsubstituted aralkyl group, a  
8 substituted or unsubstituted aryl group, a substituted  
9 or unsubstituted alkylthio group, a substituted or un-  
10 substituted alkenylthio group, a substituted or un-  
11 substituted aralkylthio group, a substituted or un-  
12 substituted arylthio group, a substituted or un-  
13 substituted heterocyclic group, a substituted or un-  
14 substituted heterocyclic thio group, a substituted or  
15 unsubstituted acylthio group, a mercapto group or a  
16 hydrogen atom, and  $R_2$  represents a hydrogen atom or a  
17 carboxyl-protecting group, or a pharmacologically ac-  
18 ~~ceptable salt thereof.~~

1 37. An antibacterial agent comprising, as an ac-  
2 tive ingredient, a penem derivative represented by the

3 following formula (I):



5 wherein  $R_1$  represents a substituted or unsubstituted  
6 alkyl group, a substituted or unsubstituted alkenyl  
7 group, a substituted or unsubstituted aralkyl group, a  
8 substituted or unsubstituted aryl group, a substituted  
9 or unsubstituted alkylthio group, a substituted or un-  
10 substituted alkenylthio group, a substituted or un-  
11 substituted aralkylthio group, a substituted or un-  
12 substituted arylthio group, a substituted or un-  
13 substituted heterocyclic group, a substituted or un-  
14 substituted heterocyclic thio group, a substituted or  
15 unsubstituted acylthio group, a mercapto group or a  
16 hydrogen atom, and  $R_2$  represents a hydrogen atom or a  
17 carboxyl-protecting group; or a pharmacologically ac-  
18 ceptable salt thereof.

*and a pharmaceutically acceptable carrier*

*B*